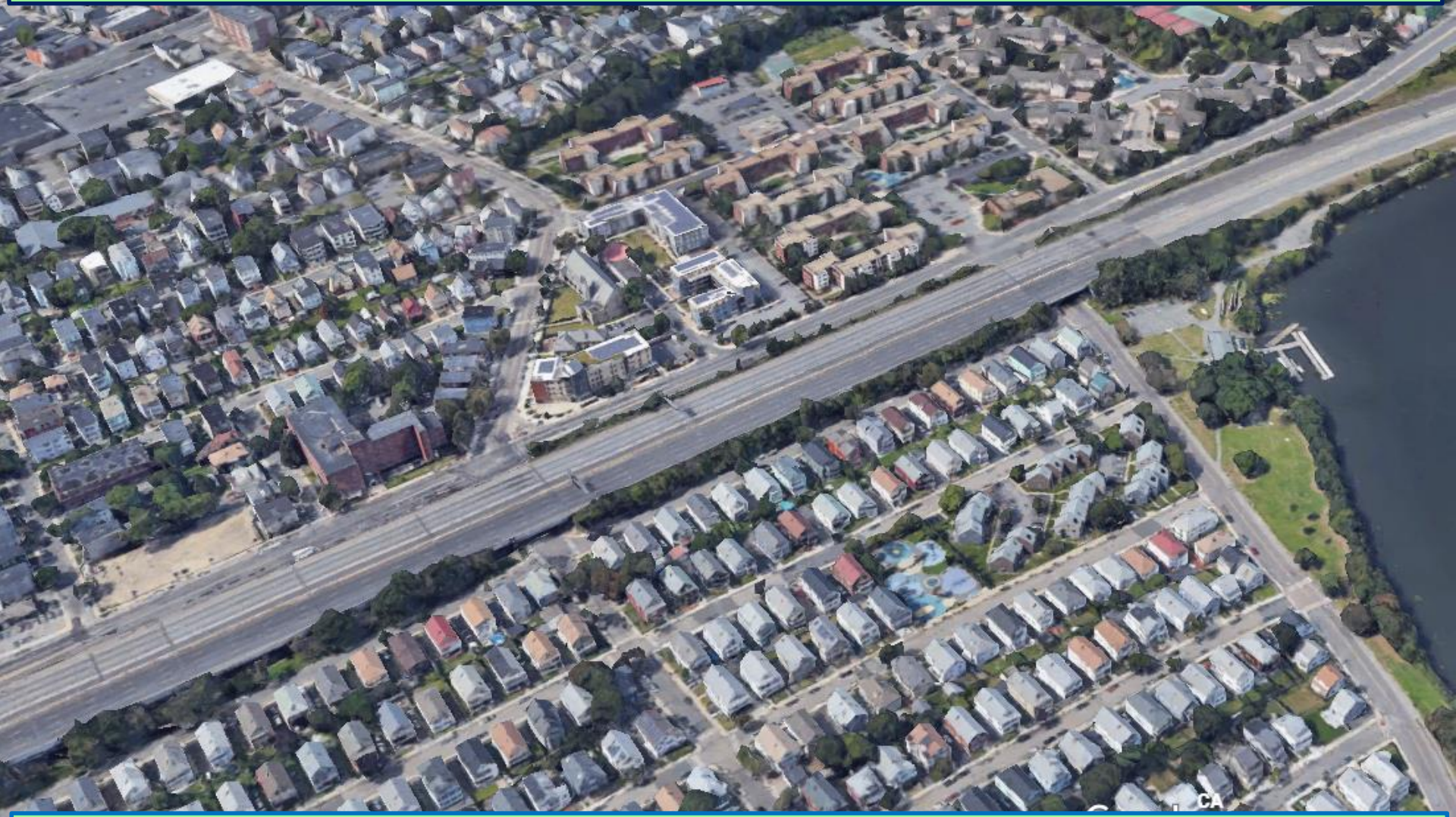


Air Filtration to reduce Ultrafine Particle Concentrations in Residential and
Other Sensitive Land Uses Near Busy Roadways in Somerville MA

Fred Berman Petition - Wig Zamore Presentation - wigzamore@gmail.com

Joint Hearing of Somerville Board of Aldermen and Planning Board - 2018 09 06



Google Earth was able to remove all vehicles from all busy roadways in Somerville

Public Elementary School
Largest Public Housing
Recent Non-Profit Housing
Highest Nitrogen Oxides
Newest Mixed Income
Dense Apartments

Maximize near roadway pollutants - 175,000 to 200,000 VPD

← Dominant Winds from NW

Boys and Girls Club
Dense Three Story
Housing Widespread



Afternoon Traffic on I93 at Somerville Medford city line

Due to highways passing through,
Somerville has the highest MA vehicle
miles traveled per square mile.



When I93 was built in the early 1970s, after the CAA
of 1970, the environmental review showed very high
levels of CO, Total Suspended PM and Lead.

Just after the Clean Air Act of 1970, there was a lot
of focus on these types of near source primary
pollutants and their near roadway health effects.

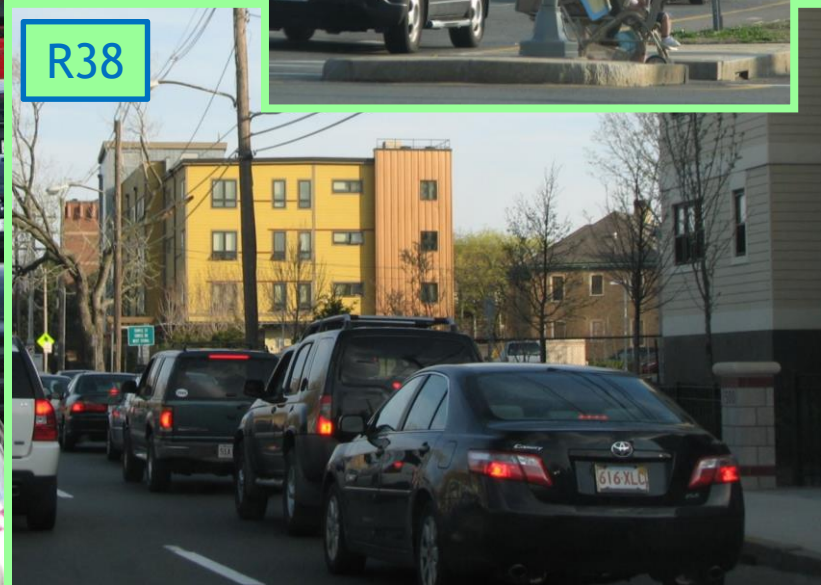
R28



R28



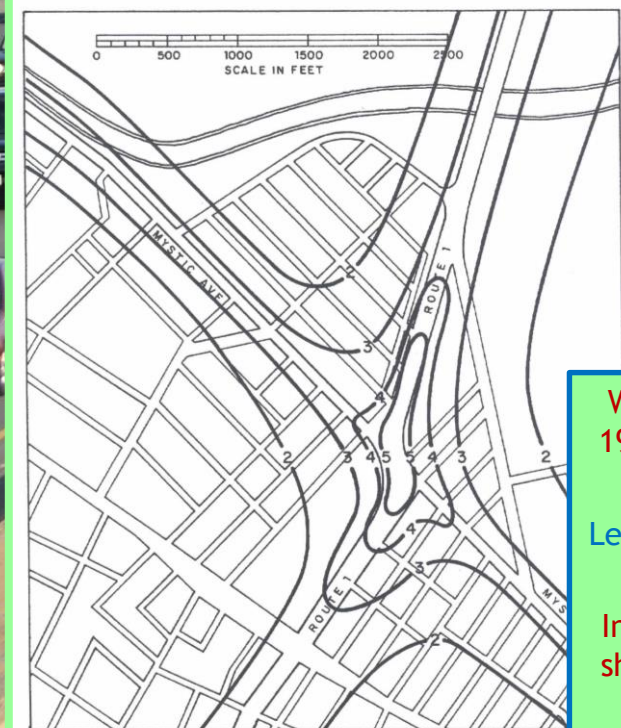
R38





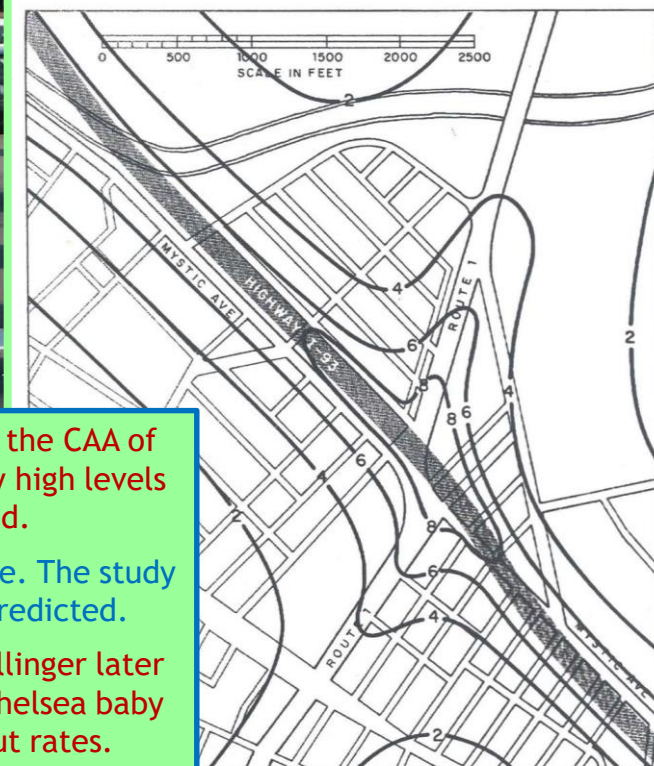
LEAD
1970
Mystic Avenue and Route 1

contours of
average concentration
micrograms per cubic meter



LEAD
1990
Mystic Avenue and Route 1
plus Highway I-93

contours of
average concentration
micrograms per cubic meter



When I93 was built in the early 1970s, after the CAA of 1970, the environmental review showed very high levels of CO, Total Suspended PM and Lead.

Lead concentrations were predicted to double. The study was buried. I93 traffic was greater than predicted.

Independent research by Needleman and Bellinger later showed high correlation of Somerville and Chelsea baby teeth lead levels and high school drop-out rates.

THE LONG-TERM EFFECTS OF EXPOSURE TO LOW DOSES OF LEAD IN CHILDHOOD

An 11-Year Follow-up Report

HERBERT L. NEEDLEMAN, M.D., ALAN SCHELL, M.A., DAVID BELLINGER, PH.D., ALAN LEVITON, M.D.,
AND ELIZABETH N. ALLRED, M.S.

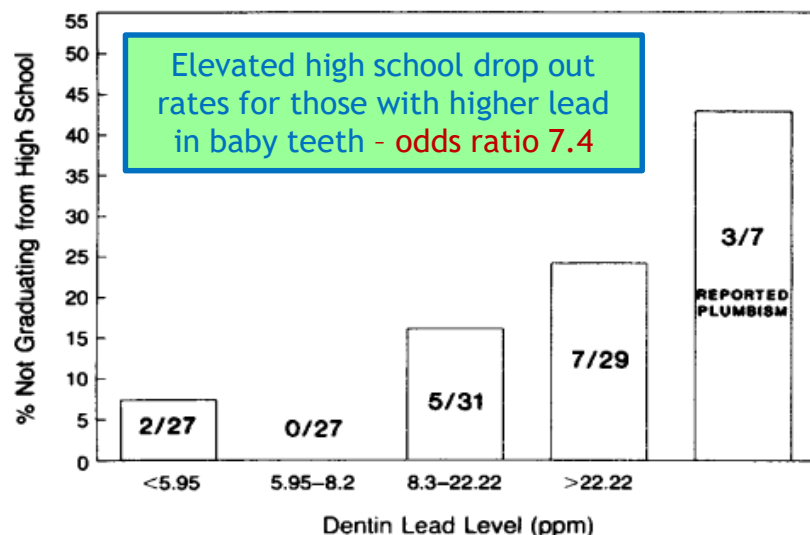
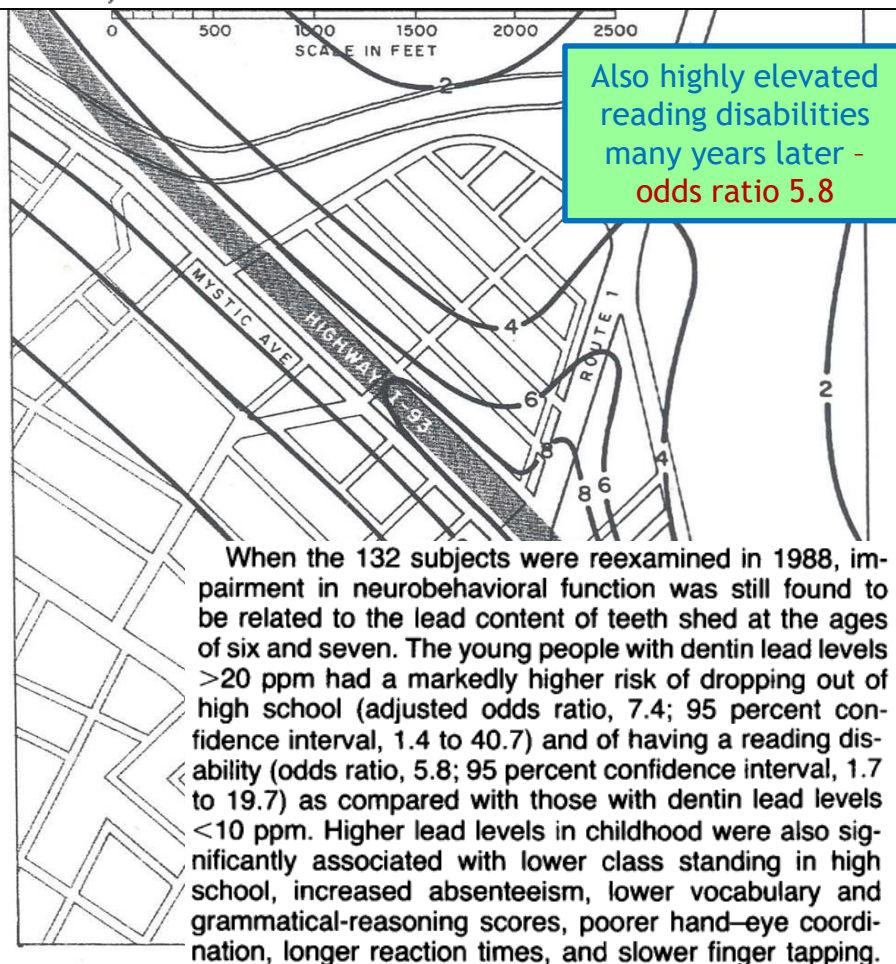


Figure 1. The Proportion of Subjects Who Did Not Graduate from High School, Classified According to Their Past Exposure to Lead.

Asymptomatic subjects are classified according to lead-level quartiles. Seven of the 10 subjects who were earlier reported to have clinical plumbism are shown in a separate column. No school records were found for two subjects. One subject was not tested but reported that she had graduated from high school. (There are therefore 121 subjects represented in this figure.) Ten subjects (three with reported plumbism and seven asymptomatic subjects) are still attending high school and are therefore not shown here. The numbers in each column indicate the number who did not graduate and the total number in the category.



Following the Harvard Six Cities (Dockery et alia 1993) and American Cancer Society Cohort (1995 Pope et alia) studies, most air pollution and health assessments have recognized regional fine particulate matter as a major air pollutant of concern. Materials below are from the EPA PM NAAQS Second Draft Risk Assessment - Feb 2010.

Fine particulate matter (PM 2.5) and Ozone (O3) are regional pollutants with large regional impacts.

However, in recent years scientists have turned increasing attention back to near busy roadway health effects and their relationship to traffic pollutants like Ultrafine Particulate Matter (UFP), 100 nanometers or smaller in diameter and usually measured as Particle Number Count (UFP PNC). Through pilot studies and the Community Assessment of Freeway Exposure and Health (CAFEH), Somerville has been a major study area for UFP.



Figure 5-2 2005 fused surface baseline PM_{2.5} concentrations

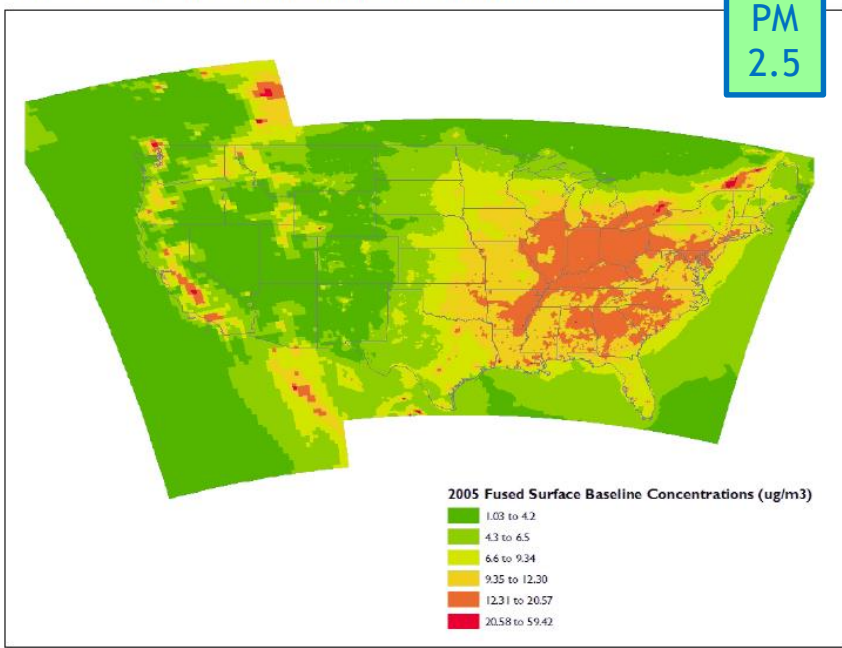


Table 5-1 Estimated PM_{2.5}-related premature mortality associated with incremental air quality differences between 2005 ambient mean PM_{2.5} levels and lowest measured level from the epidemiology studies or policy relevant background (90th percentile confidence interval)

Air Quality Level	Estimates Based on Krewski et al. (2009)		Estimates Based on Laden et al. (2006)
	'79-'83 estimate (90th percentile confidence interval)	'99-'00 estimate (90th percentile confidence interval)	(90th percentile confidence interval)
10 µg/m ³ (LML for Laden et al., 2006)	26,000 (16,000—36,000)	33,000 (22,000—44,000)	88,000 (49,000—130,000)
5.8 µg/m ³ (LML for Krewski et al., 2009)	63,000 (39,000—87,000)	80,000 (54,000—110,000)	210,000 (120,000—300,000)
Policy-Relevant Background	110,000 (68,000—150,000)	140,000 (94,000—180,000)	360,000 (200,000—500,000)

Bold indicates that the minimum air quality level used to calculate this estimate corresponds to the lowest measured level identified in the epidemiological study

Near roadway health risks – cardiovascular and lung cancer deaths, childhood asthma

TABLE 3. Associations Between Exposure to Traffic at Home and Asthma History

Exposure Metric	Odds Ratio per IQR OR* (95% CI)
Distance to freeway	1.89 (1.19–3.02)
Traffic volume within 150 meters	1.45 (0.73–2.91)
Model-based pollution from:	
Freeways	2.22 (1.36–3.63)
Other roads	1.00 (0.75–1.33)
Freeways and other roads	1.40 (0.86–2.27)

*Odds ratio per change of 1 IQR. For distance to freeway, OR for the 25th percentile compared with the 75th percentile (ie, living closer compared with farther from the freeway). For remaining traffic variables, OR for the 75th percentile compared with the 25th percentile. All models were adjusted for sex, race, Hispanic ethnicity, cohort, and community.

Heart Disease Mortality
50% higher for those living near highways –
Gan ... Brauer
VANCOUVER 2010

Childhood Asthma
roughly 100% higher for children with most traffic pollution at home – Gauderman ... McConnell S. CAL. 2005

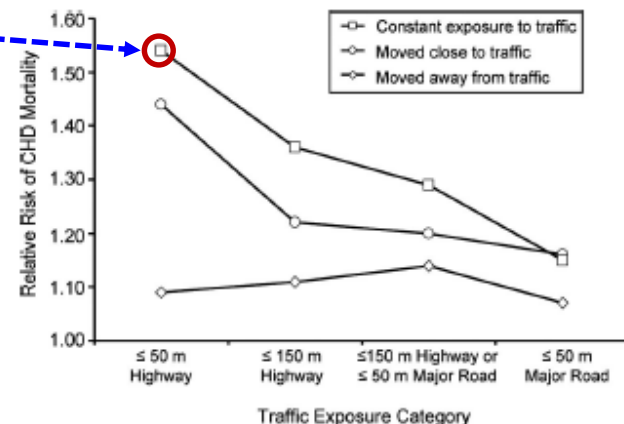


FIGURE 1. Association of road traffic exposure with coronary heart disease mortality by road types and distances. RRs adjusted for age, sex, neighborhood SES, and pre-existing comorbidities.

Table 2. Risk of Autism for 524 Children, by Quartile^a of Modeled Traffic-Related Air Pollution Exposure From All Road Types

Time Period	Odds Ratio (95% CI)		
	4th Quartile	3rd Quartile	2nd Quartile
First year of life			
Crude	2.97 (1.71–5.27)	1.00 (0.63–1.60)	0.88 (0.55–1.42)
Adjusted ^b	3.10 (1.76–5.57)	1.00 (0.62–1.62)	0.91 (0.56–1.47)
All pregnancy			
Crude	1.99 (1.22–3.28)	1.10 (0.67–1.78)	1.20 (0.74–1.95)
Adjusted ^b	1.98 (1.20–3.31)	1.09 (0.67–1.79)	1.26 (0.77–2.06)

Childhood Autism Risk 100% to 200% higher for kids with most traffic pollution is a BIG emerging concern – Volk ... McConnell S. CAL 2012

Lung Cancer Mortality
60% higher for those with most traffic pollution – Nyberg STOCKHOLM 2000

Variable	Both Pollutants†	
	RR‡	95% CI‡
<u>NO₂ from road traffic</u>		
Continuous variable (per 10 µg/m ³)	1.15	0.97–1.35
Quartiles and 90th percentile		
<12.78 µg/m ³	1	
≥12.78 to <17.35 µg/m ³	1.19	0.91–1.56
≥17.35 to <23.17 µg/m ³	1.11	0.83–1.48
≥23.17 to <29.26 µg/m ³	1.19	0.86–1.66
≥29.26 µg/m ³	1.60	1.07–2.39
<u>SO₂ from heating</u>		
Continuous variable (per 10 µg/m ³)	0.99	0.95–1.02
Quartiles and 90th percentile		
<66.20 µg/m ³	1	
≥66.20 to <87.60 µg/m ³	1.07	0.83–1.40
≥87.60 to <110.30 µg/m ³	0.90	0.67–1.19
≥110.30 to <129.10 µg/m ³	0.80	0.58–1.12
≥129.10 µg/m ³	0.95	0.64–1.39

Putting it all together in one study .. from Denmark ...

A Study of the Combined Effects of Physical Activity and Air Pollution on Mortality in Elderly Urban Residents: The Danish Diet, Cancer, and Health Cohort

Zorana Jovanovic Andersen,^{1,2} Audrey de Nazelle,³ Michelle Ann Mendez,⁴ Judith Garcia-Aymerich,^{5,6,7} Ole Hertel,⁸ Anne Tjønneland,² Kim Overvad,^{9,10} Ole Raaschou-Nielsen,² and Mark J. Nieuwenhuijsen^{5,6,7}

Physical activity	Main model	
	Crude ^a model	Fully adjusted ^b model
Total mortality (<i>n</i> = 5,534)		
Sports	0.62 (0.59, 0.65)	0.78 (0.73, 0.82)
Cycling	0.77 (0.73, 0.81)	0.83 (0.78, 0.88)
Gardening	0.72 (0.68, 0.77)	0.84 (0.79, 0.89)
Walking	0.91 (0.83, 1.00)	0.97 (0.88, 1.06)
Cancer mortality (<i>n</i> = 2,864)		
Sports	0.66 (0.62, 0.72)	0.82 (0.76, 0.89)
Cycling	0.86 (0.80, 0.93)	0.93 (0.86, 1.01)
Gardening	0.87 (0.80, 0.94)	0.96 (0.88, 1.04)
Walking	1.00 (0.87, 1.15)	1.06 (0.93, 1.23)
Cardiovascular mortality (<i>n</i> = 1,285)		
Sports	0.61 (0.54, 0.69)	0.78 (0.69, 0.88)
Cycling	0.73 (0.66, 0.82)	0.78 (0.69, 0.88)
Gardening	0.85 (0.71, 1.03)	0.82 (0.72, 0.93)
Walking	0.85 (0.71, 1.03)	0.88 (0.73, 1.07)
Respiratory mortality (<i>n</i> = 354)		
Sports	0.40 (0.31, 0.50)	0.60 (0.47, 0.77)
Cycling	0.54 (0.43, 0.67)	0.62 (0.50, 0.77)
Gardening	0.50 (0.40, 0.63)	0.63 (0.50, 0.79)
Walking	0.63 (0.46, 0.86)	0.71 (0.51, 0.97)
Diabetes mortality (<i>n</i> = 122)		
Sports	0.28 (0.17, 0.44)	0.34 (0.21, 0.55)
Cycling	0.58 (0.40, 0.84)	0.61 (0.42, 0.89)
Gardening	0.33 (0.22, 0.48)	0.42 (0.28, 0.62)
Walking	0.74 (0.43, 1.28)	0.77 (0.44, 1.33)

This study concludes that sports, cycling and gardening are very good for reducing heart, lung and diabetes deaths

from Denmark ... Looking at low vs high traffic exposure

Cyclists in the most traffic polluted areas tended to have had higher total, cancer and heart related deaths than those who did not exercise but who lived in lower traffic areas

But tended to have lower respiratory and diabetes deaths

Table S1. Adjusted associations^a of total and cause-specific mortality with cycling among 52,061 participants in Diet, Cancer and Health cohort, by intensity of cycling and different levels of NO₂.

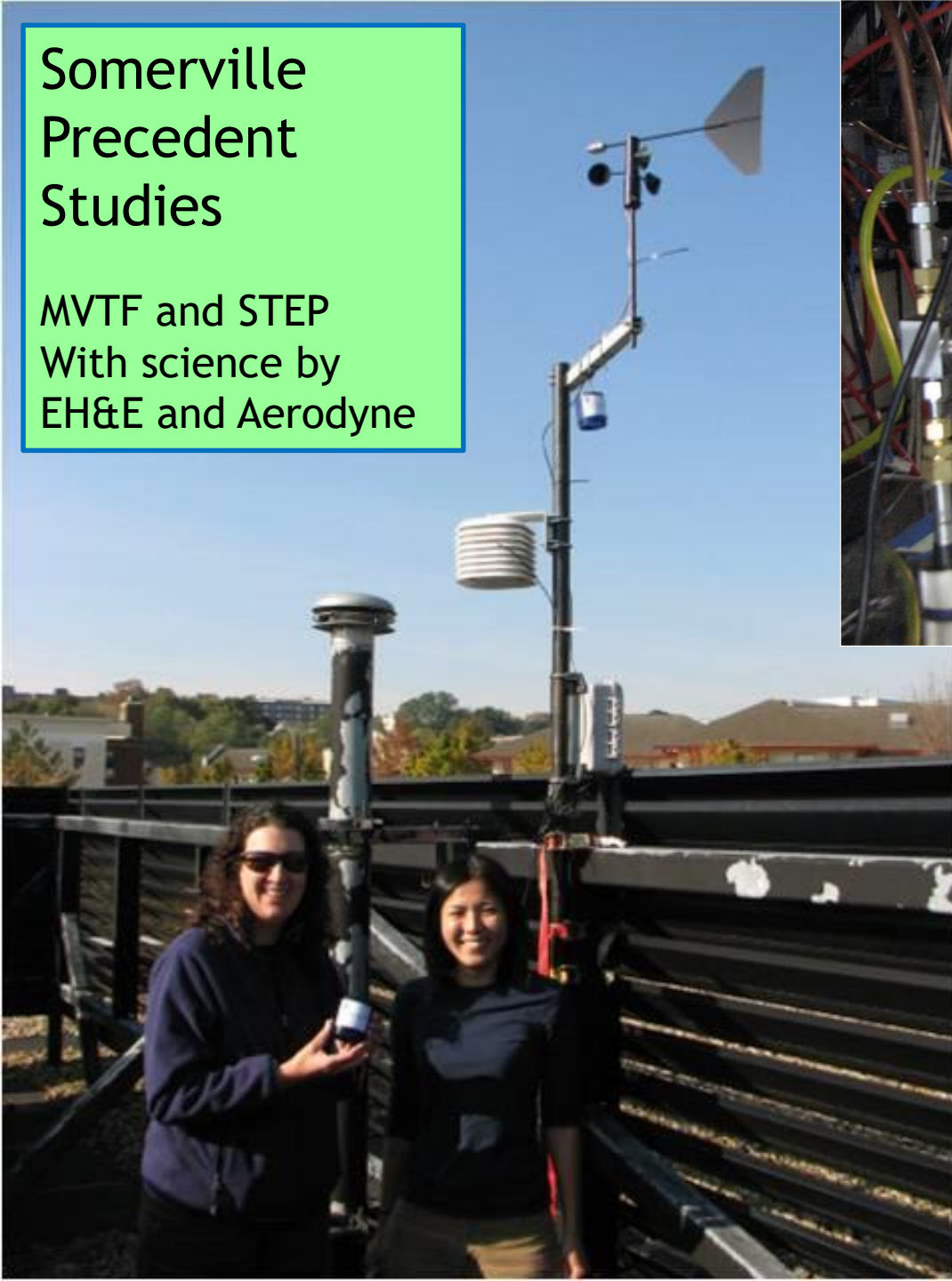
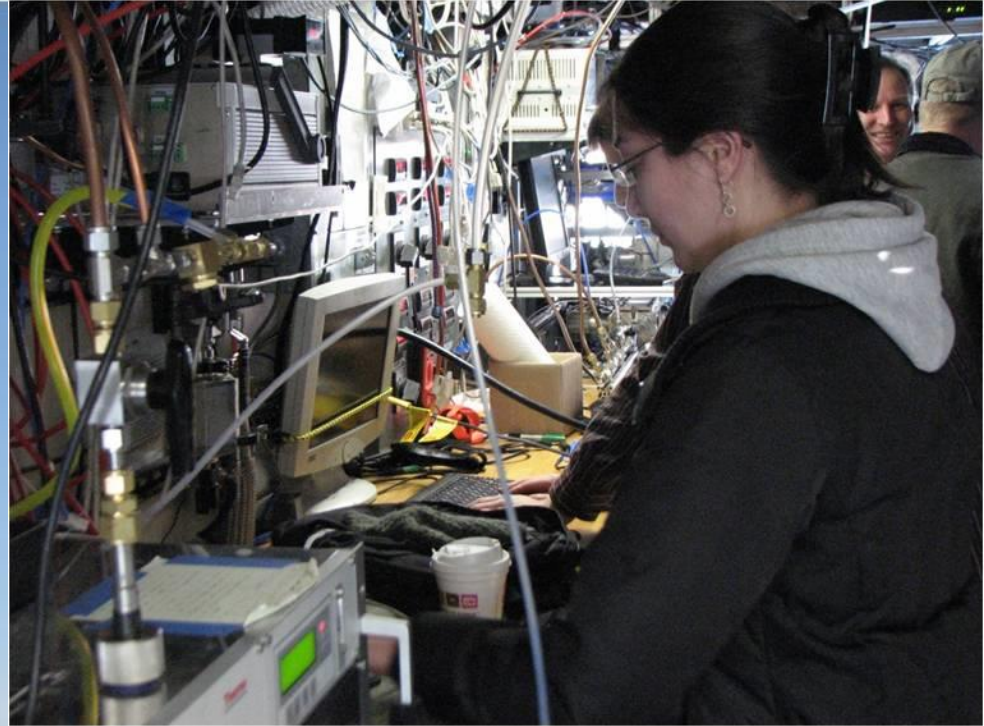
Physical Activity	Low NO ₂ ($< 15.1 \mu\text{g}/\text{m}^3$) HR (95% CI)	Moderate NO ₂ ($15.1\text{-}23.9 \mu\text{g}/\text{m}^3$) HR (95% CI)	Very high NO ₂ ($\geq 23.9 \mu\text{g}/\text{m}^3$) HR (95% CI)	p-value ^b
Total mortality (n = 5,534)				
Does not cycle	1.00	1.26 (1.15, 1.39)	1.39 (1.22, 1.58)	0.52
Cycles 0.5-4 h/week	0.87 (0.79, 0.95)	1.00 (0.91, 1.10)	1.10 (0.96, 1.26)	
Cycles >4 h/week	0.82 (0.72, 0.93)	1.02 (0.92, 1.14)	1.19 (1.01, 1.40)	
Cancer mortality (n = 2,864)				
Does not cycle	1.00	1.22 (1.07, 1.39)	1.36 (1.13, 1.64)	0.71
Cycles 0.5-4 h/week	0.97 (0.86, 1.10)	1.09 (0.96, 1.23)	1.19 (0.98, 1.45)	
Cycles >4 h/week	0.91 (0.76, 1.08)	1.14 (0.99, 1.33)	1.16 (0.92, 1.47)	
Cardiovascular mortality (n = 1,285)				
Does not cycle	1.00	1.36 (1.13, 1.64)	1.78 (1.39, 2.29)	0.78
Cycles 0.5-4 h/week	0.83 (0.68, 1.01)	1.09 (0.90, 1.31)	1.21 (0.91, 1.61)	
Cycles >4 h/week	0.73 (0.55, 0.96)	0.98 (0.78, 1.23)	1.38 (1.00, 1.91)	
Respiratory mortality (n = 354)				
Does not cycle	1.00	1.02 (0.74, 1.40)	0.73 (0.45, 1.18)	0.78
Cycles 0.5-2 h/week	0.56 (0.39, 0.81)	0.72 (0.51, 1.02)	0.48 (0.26, 0.89)	
Cycles >4 h/week	0.49 (0.28, 0.85)	0.57 (0.37, 0.88)	0.57 (0.29, 1.12)	
Diabetes mortality (n = 122)				
Does not cycle	1.00	1.36 (0.79, 2.37)	1.20 (0.56, 2.53)	0.98
Cycles 0.5-2 h/week	0.69 (0.35, 1.34)	0.86 (0.46, 1.61)	0.69 (0.25, 1.84)	
Cycles >4 h/week	0.55 (0.21, 1.47)	0.75 (0.36, 1.56)	0.56 (0.16, 1.91)	

HR hazard ratio; CI confidence interval.

^aAdjusted for NO₂, gender, calendar year, and mutually for other three physical activities, occupational physical activity, smoking status, smoking intensity, smoking duration, alcohol intake, environmental tobacco smoke, education, fruit and vegetable intake, fat intake, risk occupation, mean income in municipality, and stratified by marital status. ^bp-value for interaction.

Somerville Precedent Studies

MVTF and STEP
With science by
EH&E and Aerodyne

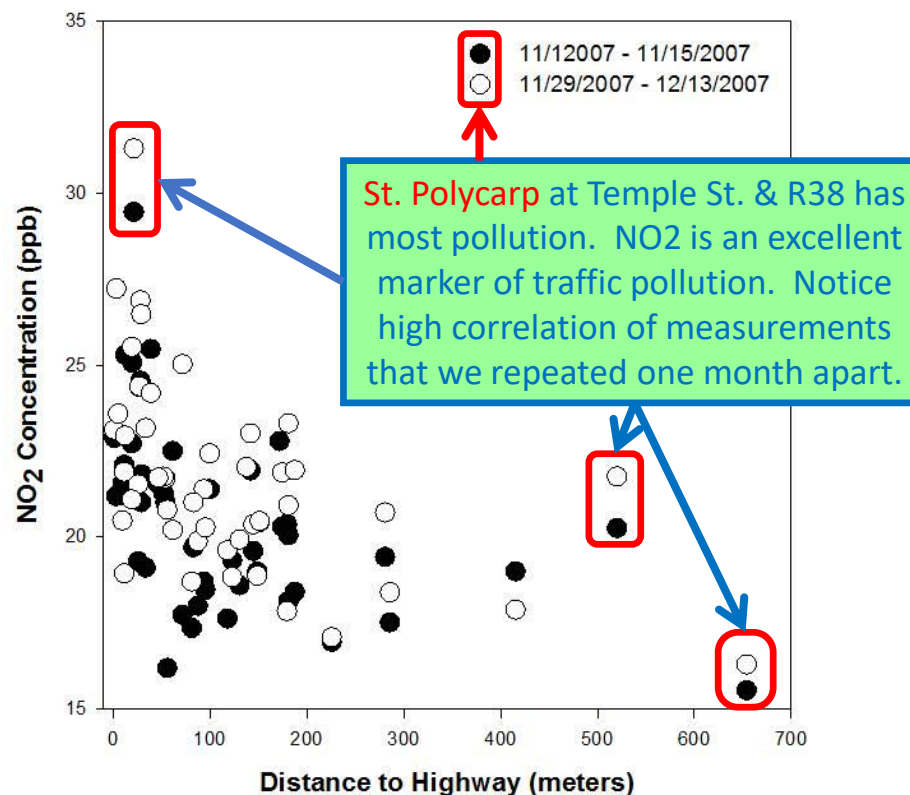


NO₂ Levels

WE STARTED TO DO REAL RESEARCH
WITH THE BOSTON AREA SCIENTISTS

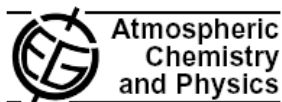
- Two-week averages
 - Mean (SD): 20.6 (2.7) ppb
 - Range: 15 – 32 ppb
- NO₂ weakly correlated with distance (m) to highway
 - I-93: -0.19 ($p=0.06$)
 - MA-28: -0.28 ($p=0.006$)

- NO₂ strongly correlated with traffic density (TD)
 - TD_{25m}: 0.61 ($p<0.0001$)
 - TD_{50m}: 0.60 ($p<0.0001$)
 - TD_{100m}: 0.48 ($p<0.0001$)



Pilot study by Mystic View Task Force, Aerodyne Research and Tufts showed Elevated pollutants downwind of highway during first half of AM rush hour

Atmos. Chem. Phys., 10, 8341–8352, 2010
www.atmos-chem-phys.net/10/8341/2010/
doi:10.5194/acp-10-8341-2010
© Author(s) 2010. CC Attribution 3.0 License.



193 AM Rush Hour Somerville MA Higher traffic pollution early

Short-term variation in near-highway air pollutant gradients on a winter morning

J. L. Durant¹, C. A. Ash¹, E. C. Wood², S. C. Herndon², J. T. Jayne², W. E. Knighton³, M. R. Canagaratna², J. B. Trull¹, D. Brugge⁴, W. Zamore⁵, and C. E. Kolb²

¹Department of Civil & Environmental Engineering, Tufts University, Medford, MA, USA

²Aerodyne Research Inc., Billerica, MA, USA

³Montana State University, Bozeman, MT, USA

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Revised: 19 August 2010 – Accepted: 20 August 2010 – Published: 6 September 2010

8350

J. L. Durant et al.: Short-term variation in near-highway air pollutant gradi

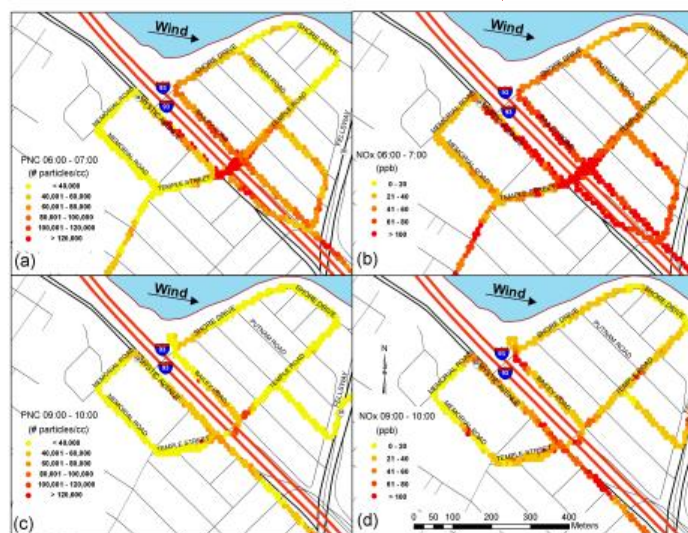
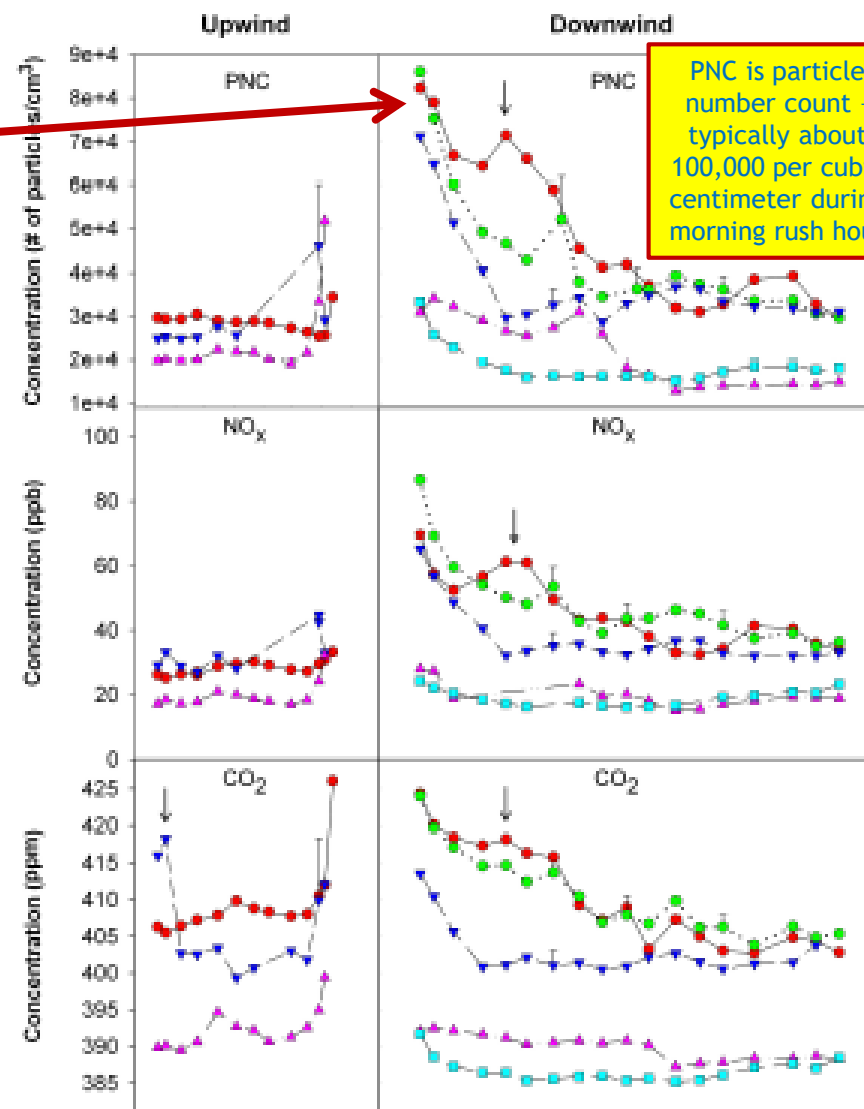


Fig. 8. Spatial distribution of particle number concentration (7–1000 nm) (a and c) and NO_x concentration (b and d) measured between 06:00–07:00 and between 09:00–10:00.



Data collected January 16 2008

Community Assessment of Freeway Exposures and Health (CAFEH) Somerville (and Chelsea) Characteristics - Susceptible and Vulnerable

“RV” = Research Vehicle



Particle Pollutants:

Particle number concentration and size distribution, $PM_{2.5}$, black carbon, and pPAHs

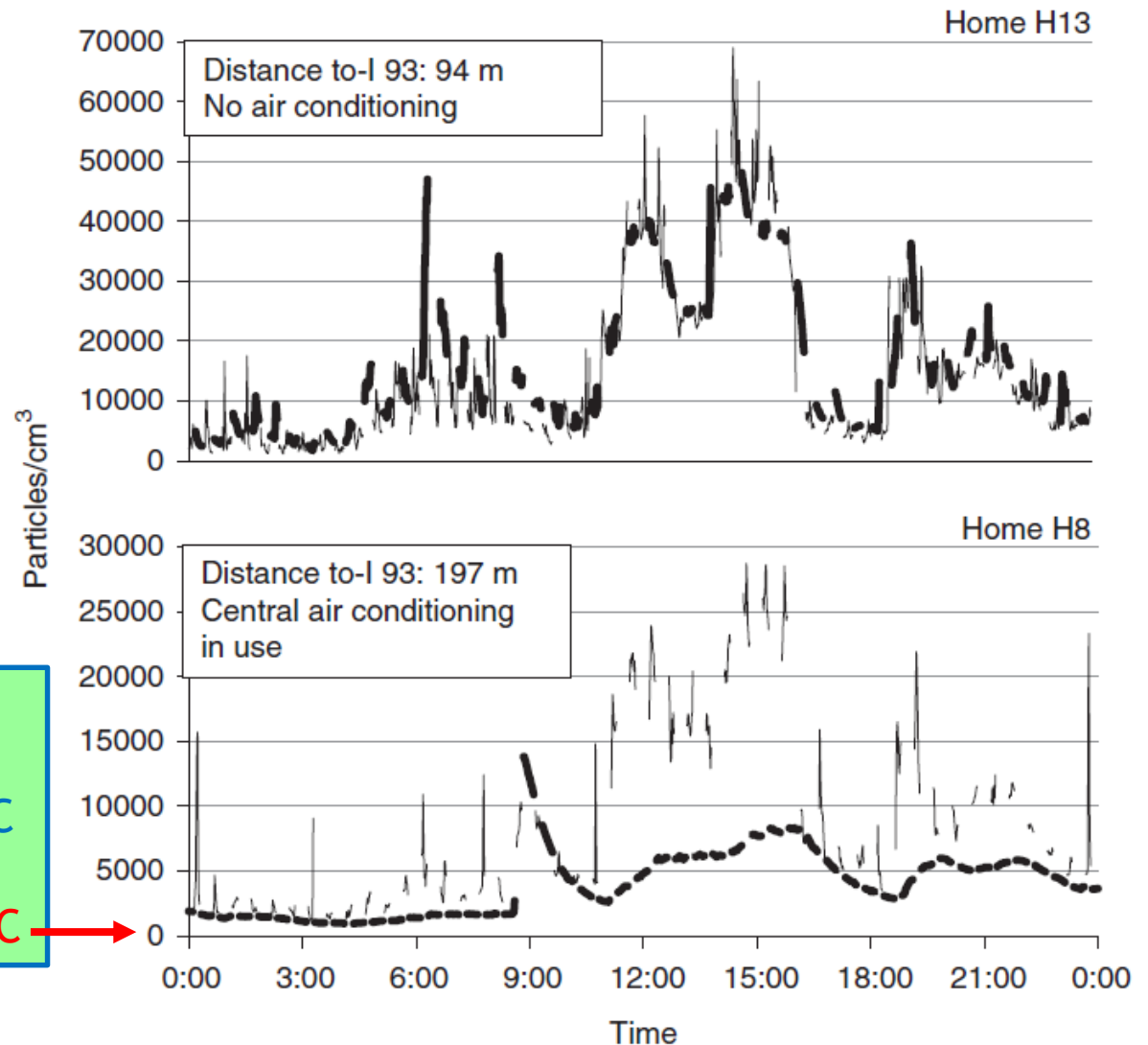
Allison Patton and Jess Perkins
of Tufts University in mobile lab

Gas Pollutants:

NO_x , NO, CO

Photographs courtesy of Alonso
Nichols, Tufts University
Photography





Christina Hemphill Fuller
JESEE 2013 Indoor Outdoor
PNC influenced by Central AC

Much lower PNC in Central AC

Figure 3. Time-series data for two homes monitored simultaneously on 14 June 2010 for indoor (thick line) and outdoor (thin line) particle number concentration. Note the different scales of the y-axes.

Kevin J Lane 2013 EH
Refined Time Activity

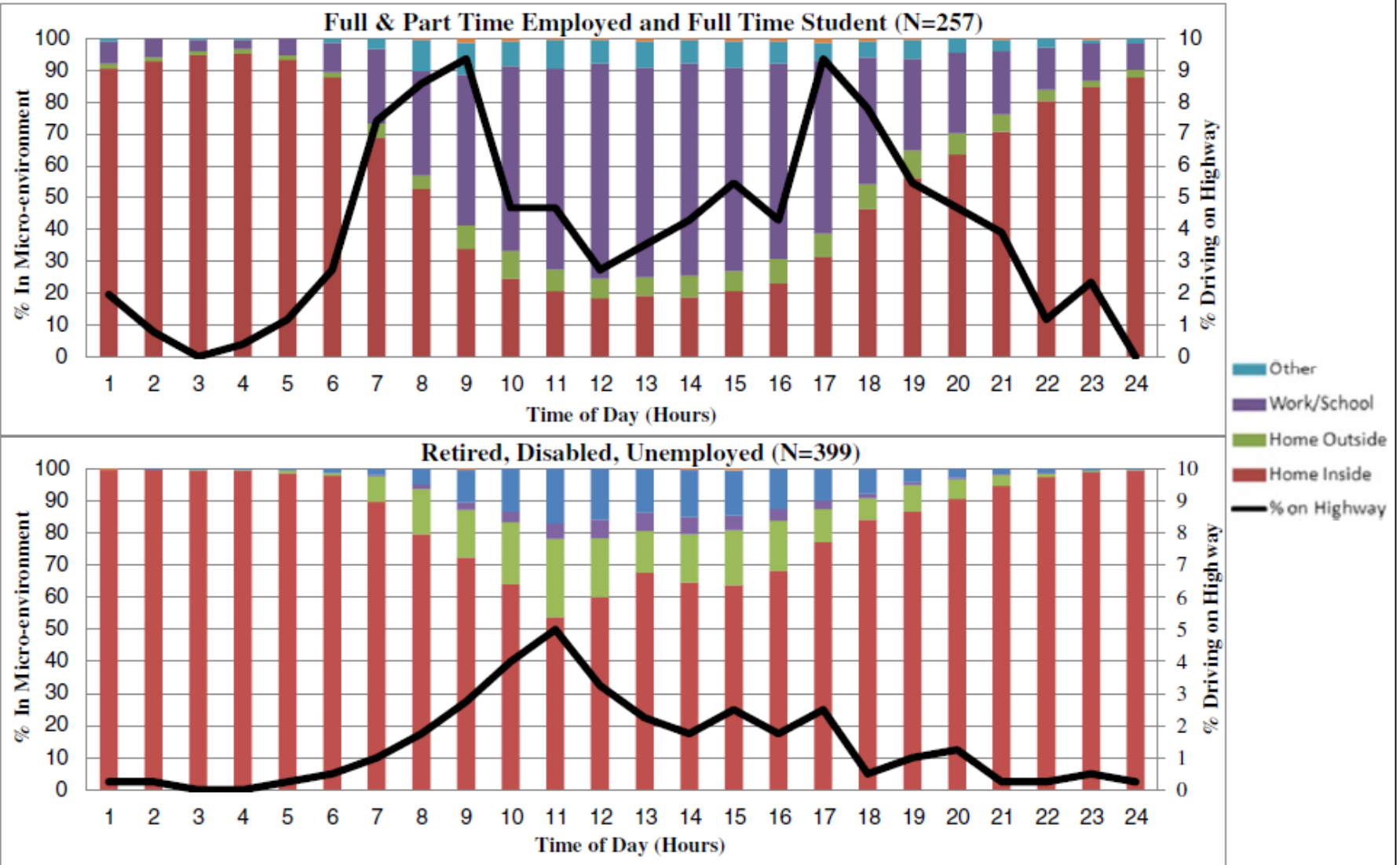


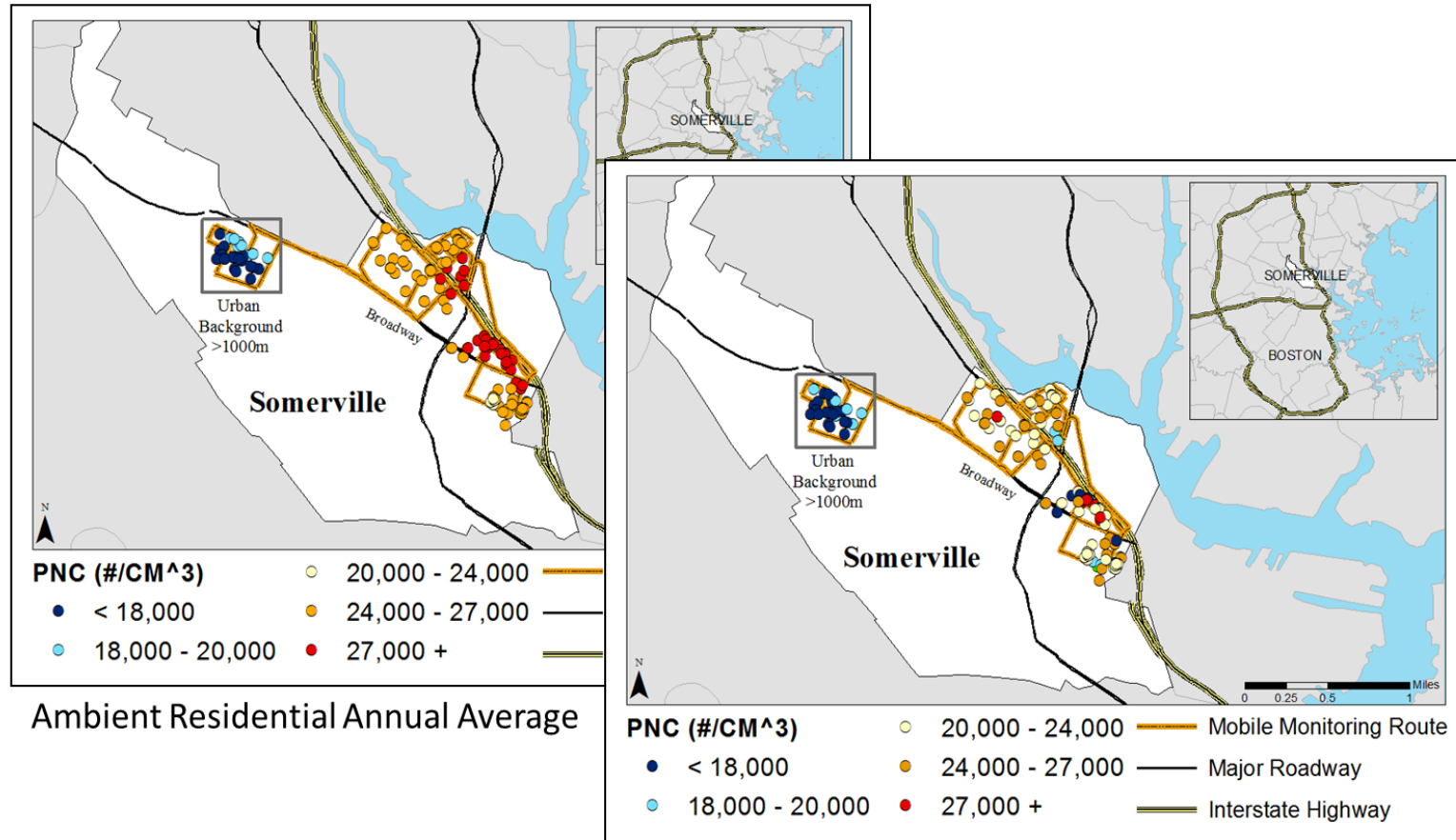
Figure 4 Hourly micro-environment time-activity data for most recent workday/weekday by employment status.

Lane 2015
JESEE

Time activity
adjustment
differentially
reduced
exposures
for near
highway
participants

Time activity
tends to
move study
participants'
exposures
toward the
center

Comparison of PNC Annual Average Exposure Models (N=140)



2

5

One of first research groups in the world to show statistical association of Near Roadway Ultrafine Particles with the most used **Cardiovascular Risk Biomarkers**:
C Reactive Protein and Interleukin 6 - Somerville data only

2

Time-activity adjustment and exposure assessment
Lane *et al*

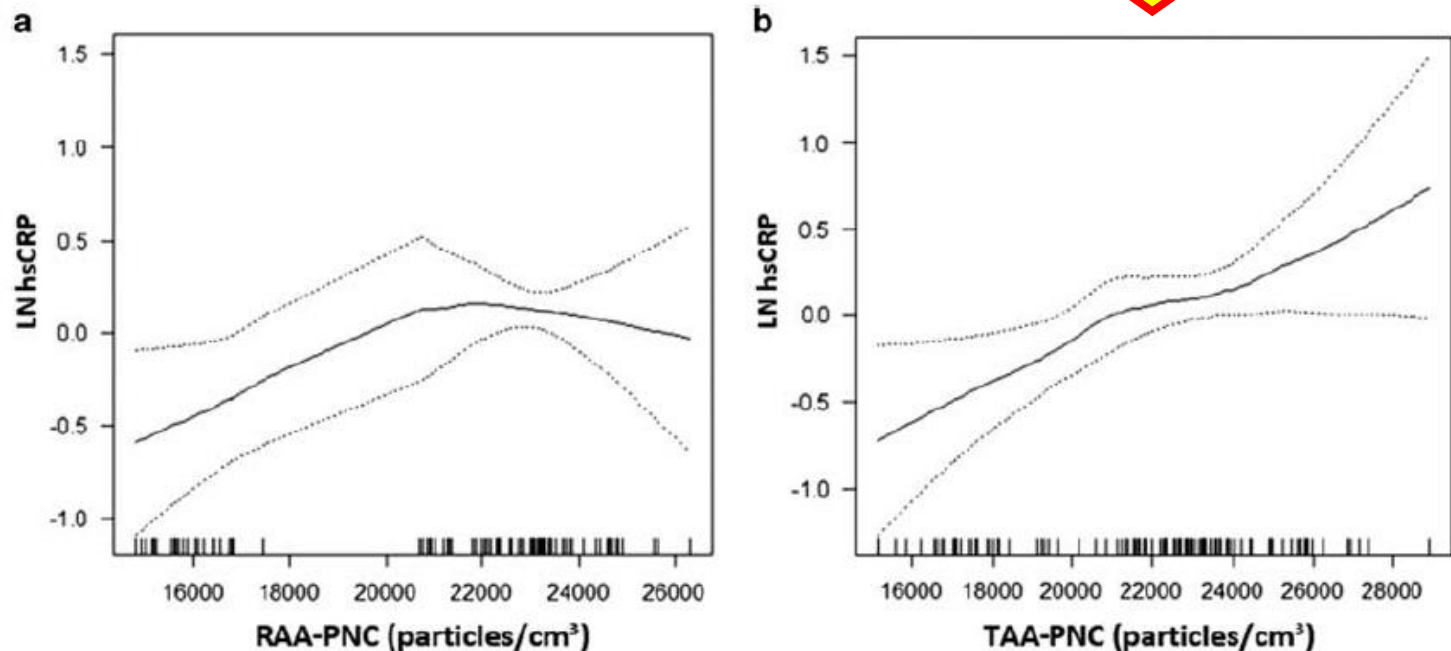
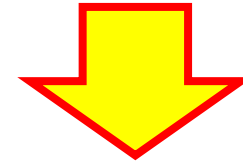


Figure 3. GAM model comparison of the effect of PNC exposure models on LN hsCRP.

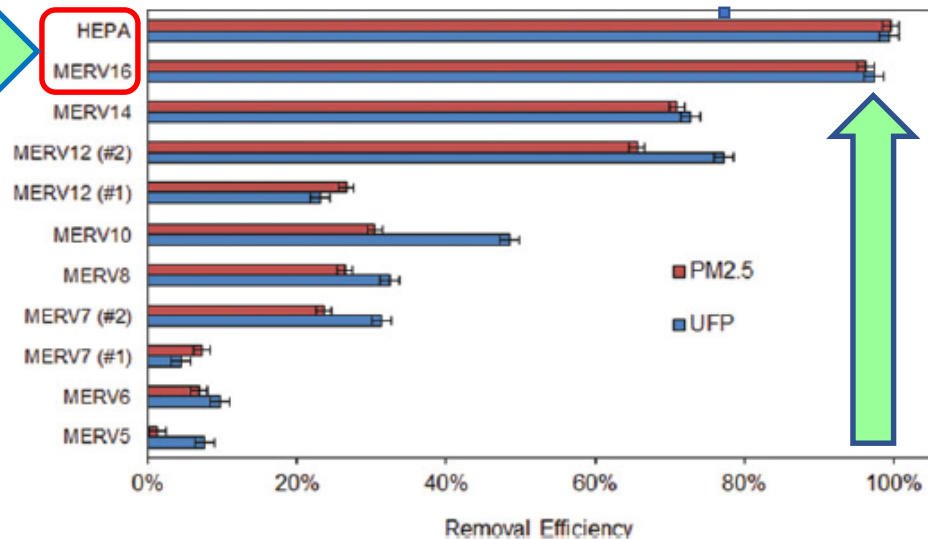
Modeling the impact of residential HVAC filtration on indoor particles of outdoor origin (RP-1691)

PARHAM AZIMI, DAN ZHAO, and BRENT STEPHENS*

Department of Civil, Architectural and Environmental Engineering, Illinois Institute of Technology, 3201 S Dearborn Street, Chicago, IL 60616, USA

Much of human exposure to airborne particles of outdoor origin, including fine particles smaller than $2.5 \mu\text{m}$ ($\text{PM}_{2.5}$) and ultrafine particles smaller than $0.1 \mu\text{m}$ (UFPs), occurs in residences. High-efficiency central HVAC filters are increasingly being used in residences, but questions remain about their effectiveness in reducing indoor $\text{PM}_{2.5}$ and UFPs of outdoor origin in homes operating under realistic conditions (e.g., with HVAC systems operating only to meet heating or cooling demands). Here dynamic building energy and indoor air mass balance modeling are combined to estimate the impacts of 11 HVAC filters (minimum efficiency reporting value [MERV] 5 through high-efficiency particulate air [HEPA]) on indoor concentrations of $\text{PM}_{2.5}$ and UFPs of outdoor origin in multiple vintages of prototypical single-family residences relying on either infiltration or mechanical ventilation systems in 22 U.S. cities. Results demonstrate that higher-efficiency HVAC filters can meaningfully reduce indoor proportions of outdoor $\text{PM}_{2.5}$ and UFPs inside residences, but home vintage, climate zone, and ventilation strategy strongly influence the outcomes due to widely varying air exchange rates, HVAC system runtimes, and sources of ventilation air. Higher efficiency filters had a greater impact in older, leakier homes relying on infiltration alone and in new homes relying on supply-only mechanical ventilation systems designed to meet ASHRAE Standard 62.2.

MERV 16 and HEPA (equivalent to MERV 17 to MERV 20) air filtration systems are the most effective at reducing indoor Particle Number Counts



Estimates of HVAC filtration efficiency for fine and ultrafine particles of outdoor origin

Parham Azimi, Dan Zhao, Brent Stephens*

Department of Civil, Architectural and Environmental Engineering, Illinois Institute of Technology, Chicago, IL, USA

HIGHLIGHTS

- We estimate HVAC filter removal efficiencies for PM_{2.5} and UFPs of outdoor origin.
- Both UFP and PM_{2.5} removal efficiency tend to increase with increasing MERV.
- Outdoor PSDs and particle density do not substantially impact PM_{2.5} removal efficiencies.
- Outdoor PSDs and infiltration factors do impact UFP removal efficiencies.
- This work informs how MERV relates to outdoor PM_{2.5} and UFP removal efficiency.

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ABSTRACT

This work uses 194 outdoor particle size distributions (PSDs) from the literature to estimate single-pass heating, ventilating, and air-conditioning (HVAC) filter removal efficiencies for PM_{2.5} and ultrafine particles (UFPs; <100 nm) of outdoor origin. The PSDs were first fitted to tri-modal lognormal distributions and then mapped to size-resolved particle removal efficiency of a wide range of HVAC filters identified in the literature. Filters included those with a minimum efficiency reporting value (MERV) of 5, 6, 7, 8, 10, 12, 14, and 16, as well as HEPA filters. We demonstrate that although the MERV metric defined in ASHRAE Standard 52.2 does not explicitly account for UFP or PM_{2.5} removal efficiency, estimates of filtration efficiency for both size fractions increased with increasing MERV. Our results also indicate that outdoor PSD characteristics and assumptions for particle density and typical size-resolved infiltration factors (in the absence of HVAC filtration) do not drastically impact estimates of HVAC filter removal efficiencies for PM_{2.5}. The impact of these factors is greater for UFPs; however, they are also somewhat predictable. Despite these findings, our results also suggest that MERV alone cannot always be used to predict UFP or PM_{2.5} removal efficiency given the various size-resolved removal efficiencies of different makes and models, particularly for MERV 7 and MERV 12 filters. This information improves knowledge of how the MERV designation relates to PM_{2.5} and UFP removal efficiency for indoor particles of outdoor origin. Results can be used to simplify indoor air quality modeling efforts and inform standards and guidelines.

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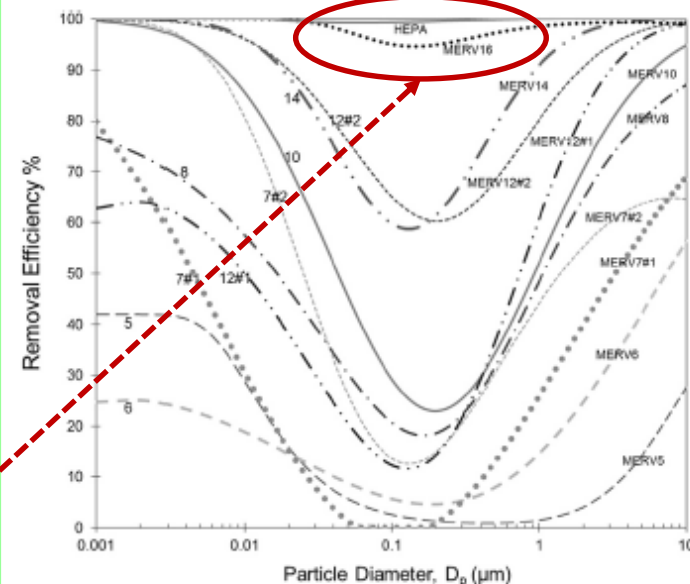


Fig. 5. Size-resolved removal efficiency of various MERV filters used herein.

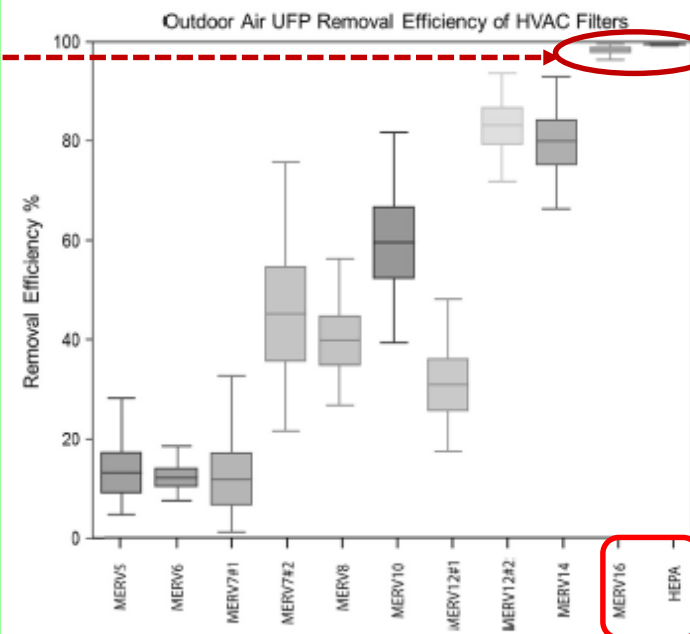


Fig. 6. Estimated distribution of UFP removal efficiency for 11 representative HVAC filters and 194 outdoor PSDs, assuming filtration of 100% OA.

Very high UFP removal
by the best filtration
systems even at the
hardest UFP sizes of
about 100 nanometers

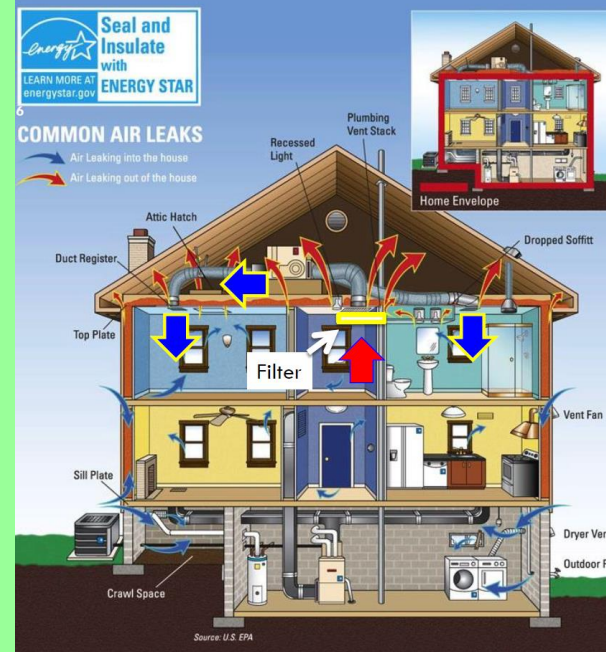
Reducing In-Home Exposure to Air Pollutants

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California Air Resources Board Contract 11-311



Residential Airflows

Windows closed: air enters via cracks & gaps

Recirculation through heating & cooling forced air unit (FAU) –

Envelope air-sealed for energy efficiency

Airtight homes have base mechanical ventilation

- Exhaust
- Supply
- Balanced

Key Results – Outdoor Particles

- The Reference configuration of exhaust ventilation in a moderately tight home reduced concentrations relative to outdoors by 66-73% for $PM_{2.5}$, 48-58% for BC and 84-87% for UFP.
- Supply ventilation with a MERV13 filter yielded slightly higher in-home concentrations of outdoor particles compared to Reference.
- MERV16 on supply ventilation or FAU operating intermittently lowered $PM_{2.5}$ by 97-98%, BC by 84-96% and UFP by 97-99%.
- MERV13 deep pleat filtration on continuous ducted heat pump reduced $PM_{2.5}$ by 95-96%, BC by 86-92% and UFP by 96%.
- A 1" MERV13 filter at the FAU return reduced $PM_{2.5}$ by 88-91%, BC by 80-84% and UFP by 83% compared to outdoors.

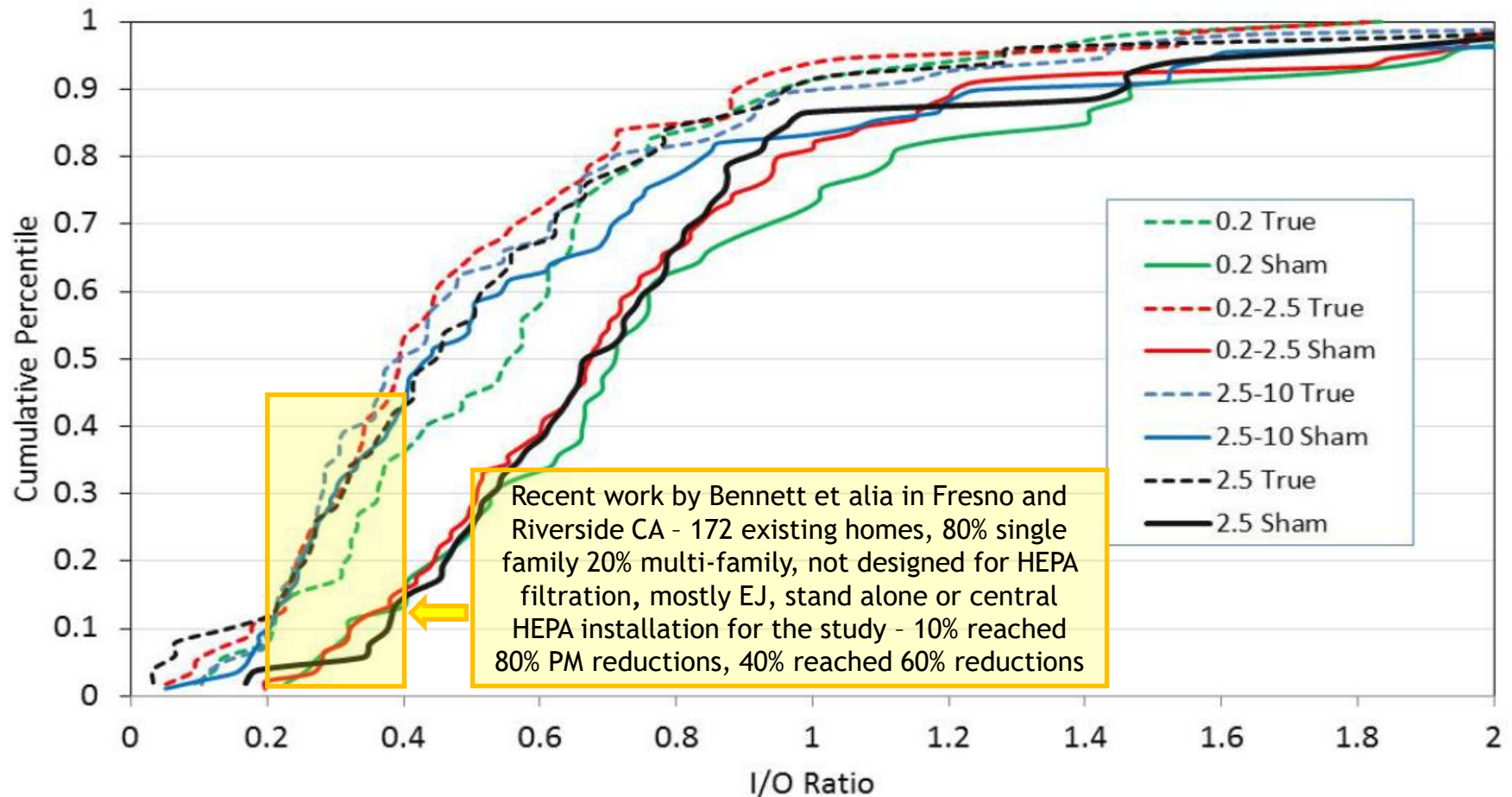
BC = Black carbon; UFP = Ultrafine particles

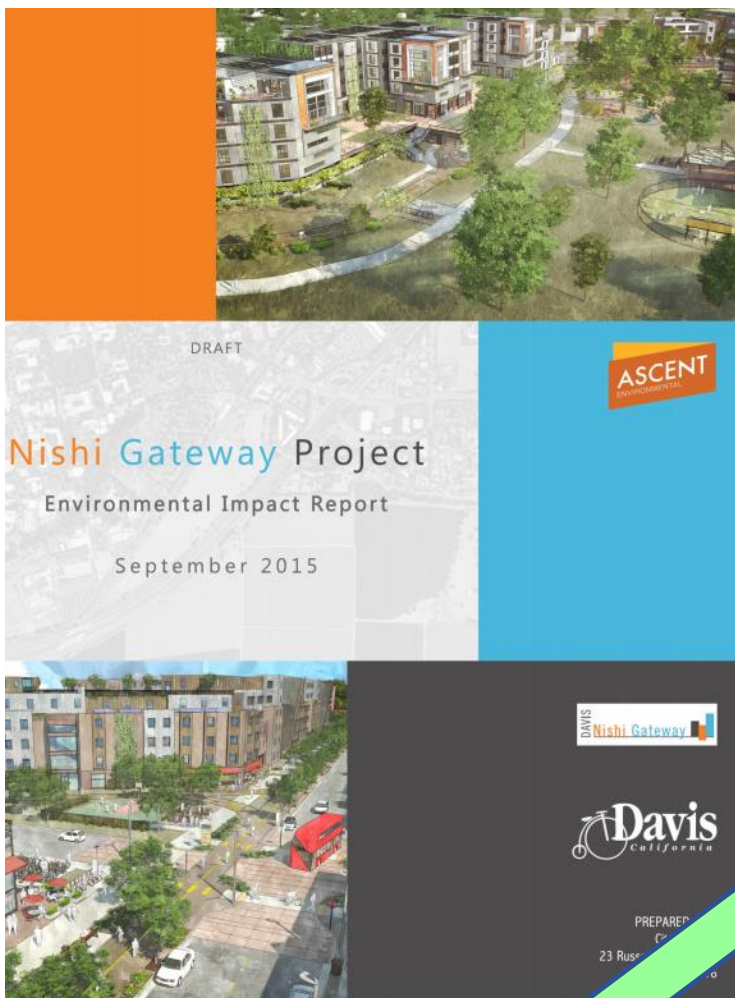
Percent reductions in particle concentrations compared to outdoors (SU, F/W)

System	$PM_{2.5}$	Black carbon	Ultrafine particles
Ref: modestly tight shell + exhaust ventilation	73, 66	58, 48	87, 84
A: MERV13 on continuous supply	67, 63	40, 38	82, 76
B: MERV13 on cont. supply + ESP on FAU	81, 70	73, 50	90, 77
C: MERV16 on blended supply	97, 98	92, 84	97, 99
D: Supply ventilation into return of FAU with MERV16 filter and 20/60 timer	97, 97	93, 96	98, 97
E: MERV13 on return of FAU on 20/60 timer with exhaust ventilation	91, 88	84, 80	93, 93
F: MERV13 on continuous ducted heat pump and exhaust ventilation	96, 95	86, 92	96, 96
G: HRV into return of FAU with HEPA bypass operating on 20/60 timer	79, 78	65, 68	83, 83
Ref + Portable HEPA units	(na), 90	(na), 85	(na), 91

Study by Bennett et alia 2018 for California Air Resources Board
Note that this study was conducted in pre-existing housing not designed
or built for air filtration and ultrafine particulate matter reduction

Distribution of I/O Ratios with and without Central System Filtration





Significance before Mitigation	Mitigation Measure	Significance after Mitigation
	<p>In its contracting language the property owner/applicant shall require its contractor (or planting/ landscaping contractor) to place orders from supply nurseries in advance to ensure that the quantity of selected nursery trees is available to fulfill the requirements of this mitigation measure.</p> <p>Mitigation Measure 4.3-5c. The air filtration systems on all residential buildings and buildings in which people work shall achieve a minimal removal efficiency of 95 percent for UFP (particulate matter with an aerodynamic diameter of 0.1 microns and smaller). Achieving a minimal removal efficiency of 95 percent may include, but not be limited to, the following:</p> <ul style="list-style-type: none"> ▲ strategically located air intakes pursuant to requirements and recommendations of the American Society of Heating, Refrigeration, and Air-Conditioning Engineers; ▲ positively pressurizing buildings; ▲ double-door entrances at the main entrances to buildings; and/or ▲ high-volume, low-pressure drop air exchange systems that cause UFP to pass through multiple filters at a slow enough speed such that they attach to the surface of standard electrostatic filters. <p>The air filtration and mechanical airflow systems shall be properly maintained and, on an annual basis, tested documented by a qualified professional to ensure that the UFP filtration system is operating at a minimum 95 percent effectiveness.</p> <p>Low cost air filtration systems capable of 95 percent efficiency include those developed by the UC Davis DELTA Group, which has designed a high-volume, low-pressure drop system that causes UFP to pass through multiple filters at a slow enough speed such that they attach to the surface of standard electrostatic filters (Cahill et al. 2014:6).</p>	
NI	No mitigation is required.	NI
LTS	No mitigation is required.	LTS

New housing at UC Davis required by City of Davis and the city's consultant ASCENT to have **95% air filtration efficiency**. Los Angeles also requires MERV 8 city wide and MERV 13 near busy roadways.